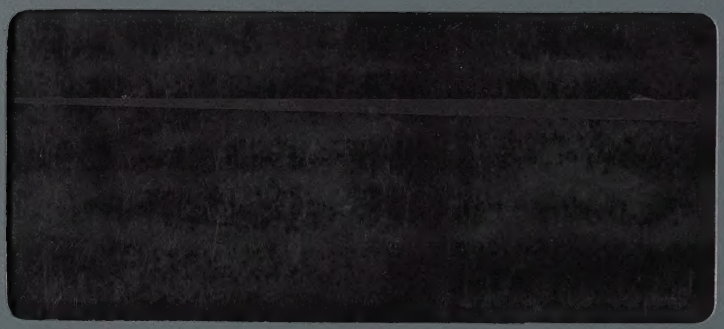
4440

Digital Multimeter-Counter

Instruction and Maintenance Manual

VALHALLA SCIENTIFIC



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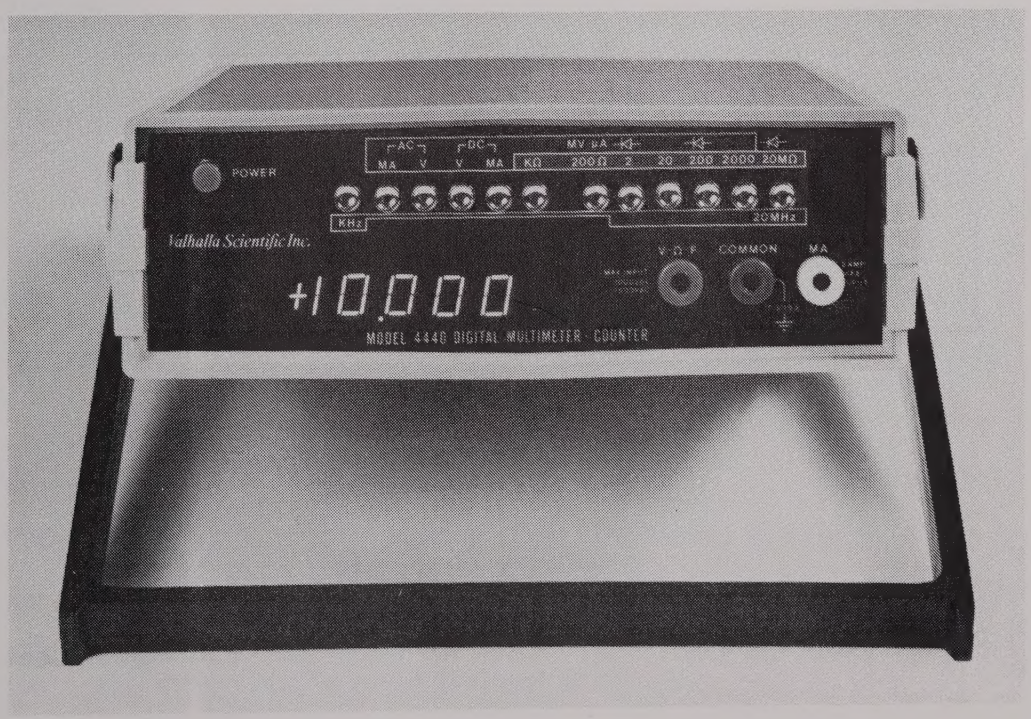

CERTIFICATION

Valhalla Scientific Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. Valhalla Scientific Inc. further certifies that its calibration measurements are traceable to the National Bureau of Standards to the extent allowed by NBS's calibration facility.

WARRANTY

Vallhalla Scientific, Inc. warrants this instrument against defects in material and workmanship for one year from date of shipment. We will repair or replace the instrument during the warranty period provided it is returned to Valhalla Scientific Inc. No other warranty is expressed or implied. We are not liable for consequential damages. Permission must be obtained directly from the factory for warranty repair returns. No liability will be accepted if returned without such permission.

MODEL 4440

SPECIFICATIONS

DC VOLTS

Range:	200 mv, 2, 20, 200, 1000 volts
Accuracy:	±0.05% of Reading, ±0.025% F.S.
Resolution:	0.005% F.S.; 10μvolts on lowest range
Input Impedance:	1000 Megohms on 200 mv and 2V range 10 Megohms on all other ranges
NMR:	50 db
CMR:	Near infinite (Battery operated)
Max Input:	1000V

AC VOLTAGE (AVERAGING)

Range:	200 mv, 2, 20, 200, 500 VRMS
Accuracy:	0.25% of Reading, ±0.25% of F.S.
Frequency:	45 Hz to 10 KHz
Resolution:	0.005% F.S., 10 μvolts on lowest range
Input Impedance:	1000 Megohms on 200 mv and 2V range 10 Megohms on all other ranges
Shunt Capacity:	50 pf
Max Input:	500 volts

AC VOLTAGE (RMS)

Ranges:	200 mv, 2V, 20V, 200V. 500v
Accuracy:	(From 5% of Range to Full Scale) ±0.5% of reading ±0.2% of range (40 Hz to 10KHz) ±1% of reading ±0.2% of range (10 KHz to 20 KHz)
Input Impedance:	1000 Megohms on 200 mv and 2V range 10 Megohms on all other ranges
Crest Factor:	3:1, Peak voltage not to exceed 150% of range to maintain full accuracy
Maximum Safe Input:	130 VRMS on 200 mv and 2V range 750V Peak on all other range not to exceed 10^7 volt-hertz

RESISTANCE

Range:	200 Ohms, 2 KOhms, 20 KOhms, 200K Ohms, 2000K Ohms, 20 MOhms
Accuracy:	0.1% of Reading, ±0.05% of F.S. to 2 MOhms; 0.5% of Reading, ±0.1% of F.S. above 2 MOhms;
Resolution:	0.005% of F.S.; 10 milliohms on lowest range
Max Input Volts:	250 VDC or Peak AC

FREQUENCY COUNTING

Range:	2 KHz, 20 KHz, 200 KHz, 2000 KHz, 20 MHz
Accuracy:	0.01% of Reading, ±0.005% of F.S.
Resolution:	0.005% of F.S.; 0.1 Hz on lowest range
Gate Time:	1 KHz - 10 sec.; 10 KHz - 1 sec.; 100 KHz - 0.1 sec.; 1000 KHz - 0.1 sec.; 10 MHz - 0.1 sec.
Sensitivity:	100 mv to 1 MHz; 250 mv to 20 MHz

DC CURRENT

Range:	200 µa, 2, 20, 200, 2000 ma
Accuracy:	±0.3% of Reading; ±0.05% of F.S.
Resolution:	0.005% of F.S.; 10 na on lowest scale
Current Shunt Voltage Drop:	200 mv F.S.
Max Input:	2 amperes on all ranges (Fuse protected)

AC CURRENT (AVERAGING)

Range:	200 µa, 2, 20, 200, 2000 ma
Accuracy:	1% of Reading ±0.1% of F.S. to 10 KHz
Resolution:	0.005% of F.S.; 10 na on lowest range
Max Input:	2 amperes on all ranges (Fuse protected)

AC CURRENT (RMS)

Ranges:	200 µa, 2, 20, 200, 2000 ma
Accuracy:	(From 5% of range to Full Scale) ±1% of reading ±0.2% of range
Voltage Burden:	0.25V RMS maximum except 2000 ma range 0.7V RMS maximum on 2000 ma range
Crest Factor:	3:1, Peak current not to exceed 150% of range to maintain full accuracy

GENERAL

Display:	LED's 0000 to 19999
Accuracy:	Specifications apply for 25°C ±5°C for 90 days
Temperature:	0 to 50°C
Max CMV:	1000 volts
Conversion Rage:	Approximately 3 per second
Overload Indication:	Flashing display
Autopolarity:	Bi-polar displays (+) and (-)
Size:	8 1/2 W x 3 1/2 D x 2 1/2 H
Weight:	Approximately 3 lbs.
Power Source:	Disposable "D" cells supplied, rechargeable battery optional

Specifications apply when tested in accordance with standard Valhalla Scientific test procedures.

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SECTION I

GENERAL INFORMATION

1-1 DESCRIPTION

1-2 The Valhalla Scientific Model 4440 Digital Multimeter-Counter is a complete wide-range multifunction measurement system in one package. This instrument measures: DC Voltage, AC Voltage, DC Current, AC Current, Resistance and Frequency. The Model 4440 features overload protected input ciucuits on all ranges and functions to insure damage free operation when operated within specified limits. It is powered with disposable "D" cells or with rechargeable nickel cadmium batteries.

1-3 ACCESSORIES

1-4 The Valhalla Scientific Model 4440 is shipped from the factory with a set of disposable "D" cells, or rechargeable batteries if the option is exercised, and an instruction manual.

1-5 AC CHARGER - OPTION A

1-6 The AC Charger option consists of a power transformer and rectifier system, in a sealed package, that plugs into the 115 VAC wall outlet and into the rear of the instrument. It will remove the load from the disposable batteries, thereby extending their useful life. The unit will charge nickel cadmium batteries and simultaneously power the instrument from the AC outlet.

1-7 RECHARGEABLE BATTERIES - OPTION B

1-8 The rechargeable battery option consists of four "D" size Nickel Cadmium cells that will power the instrument for 8 hours of continuous operation in the multimeter mode or for 6 hours in the frequency counter mode between recharging of the cells.

1-9 20 MHz COUNTER - OPTION F

1-10 The 20 MHz Counter option adds crystal controlled frequency counting capability up to 20 MHz. An automatic gain control on the input stage eliminates any adjustments over the dynamic range providing "hands off" operation.

1-11 TRUE RMS TO DC CONVERTER - OPTION TRMS

1-12 The Option TRMS allows the user to accurately measure non-sinusoidal wave forms.

1-13 EXTERNAL 20 AMPERE CURRENT SHUNT - OPTION I

1-14 The unit may be purchased with the external 20 Amp shunt option which extends the AC and DC current ranges to 20 Amperes full scale.

1-15 TEMPERATURE PROBE - OPTION TEMP

1-16 The option **TEMP** Temperature Probe will accurately measure surface temperatures from -50°C to 150°C.

1-17 HIGH VOLTAGE PROBE - OPTION HV-2

1-18 The High Voltage Probe, Option **HV-2** extends the range of the basic instrument to 36,000V with 2% accuracy.

1-19 INTERNAL LINE POWER - OPTION AC

1-20 Option AC provides power directly from 115 VAC line, 200 VAC 50 Hz also available.

1-21 INPUT CABLE SET - OPTION C

1-22 The Model **4440** Option "C" Input Cable Set provides direct compatibility with the front panel input connectors through shielded conductor. The input leads are terminated in two alligator clips.

SECTION II
INSTALLATION

2-1 INTRODUCTION

2-2 This section contains information for the inspection and installation of the Valhalla Scientific Model 4440 Digital Multimeter.

2-3 INITIAL INSPECTION

2-4 Before accepting the instrument from the shipper, inspect the shipping container for any signs of external damage. If damage is observed, please notify the carrier.

2-5 Unpack the instrument and retain the shipping container until the instrument has been inspected for possible damage in shipment.

2-6 POWER REQUIREMENTS

2-7 The Valhalla Scientific Model 4440 Digital Multimeter-Counter operates from a DC power supply consisting of four disposable "D" cells furnished with the instrument. Alternately, nickel-cadmium batteries may be used to extend the operational time between battery replacements. A charger is available as an option (see Section I) that will remove the load from the batteries when connected to the 115 volt AC wall outlet. It will also charge nickel cadmium batteries and simultaneously power the instrument from the AC outlet. Normal operating time between charges of the nickel cadmium batteries is 8 hours of continuous operation in the multimeter mode or 6 hours in the counter mode.

2-8 INSTALLATION

2-9 The Model 4440 is a low power device that generates little or no heat. Therefore, there are no special installation considerations other than to insure that its ambient environment is within the temperature range specified.

SECTION III

OPERATING INSTRUCTIONS

3-1 INTRODUCTION

3-2 This section contains complete operating instructions for the Model 4440 Digital Multimeter-Counter. Included is a description of the front panel controls and a list of procedures required to operate the unit in each of its measurement modes.

3-3 FRONT PANEL

3-4 The POWER SWITCH is a single push-on push-off control located at the extreme right hand side of the panel. This control energizes and de-energizes the instrument.

3-5 The FUNCTION SWITCH is a six-station, interlocking pushbutton unit located in left center of the panel. This control selects any of the six functions, KHz, AC MA, AC V, DC V, DC MA, or KΩ. In the event the KHz option is not exercised, then the KHz control is not present.

3-6 The RANGE SWITCH is a six-station, interlocking pushbutton unit located to the right of the panel center line. This control selects any of six multipliers to provide a wide range of inputs. The legends above the switch pushbuttons provide a quick reference when selecting a new range.

3-7 DC VOLTAGE MEASUREMENTS

The maximum safe input is 10,000% of range not to exceed 1000 VDC.

1. Press RANGE switch to 2000.
2. Press FUNCTION switch to DCV.
3. Connect the unknown input voltage across the front panel V-Ω-F and COMMON terminals.
4. Observe the reading and select the range that will yield the proper resolution.

3-8 DC CURRENT MEASUREMENTS

The maximum safe input is 500% of range not to exceed 2A.

1. Press RANGE switch to 2000.
2. Press FUNCTION switch to DCMA.
3. Connect the unknown input current across the front panel MA and COMM input terminals.
4. Observe the reading and select the range that will yield the proper resolution.

3-9 AC VOLTAGE MEASUREMENTS

The maximum safe input is 10,000% of range not to exceed 500V rms.

1. Press RANGE switch to 2000.
2. Press FUNCTION switch to ACV.
3. Connect the unknown input voltage across the front panel V-Ω-F and COMM input terminals.

4. Observe the reading and select the range that will yield the proper resolution.

3-10 AC CURRENT MEASUREMENTS

The maximum safe input is 500% of range not to exceed 2A.

1. Press RANGE switch to 2000.
2. Press FUNCTION switch to ACMA.
3. Connect the unknown input current across the front panel MA and COMM input terminals.
4. Observe the reading and select the range that will yield the proper resulution.

3-11 RESISTANCE MEASUREMENTS

The maximum safe input voltage is 200 VDC or peak AC.

1. Press FUNCTION switch to KΩ.
2. Press RANGE switch to 20 MΩ.
3. Connect the unknown input resistor across the front panel V-Ω-F and COMM input terminals.
4. Observe the reading and select the range that will yield the proper resolution.

NOTE

Use a shielded input cable when measuring high resistance values.

3-12 FREQUENCY MEASUREMENTS (with Option F installed)

The maximum safe input voltage is 250V rms.

1. Press FUNCTION switch to KHz.
2. Press RANGE switch to 20 MHz.
3. Connect the unknown input frequency across the front panel V-Ω-F and COMM input terminals.
4. Observe the reading and select the range that will yield the proper resolution. Out of range indications are characterized by a flashing display.

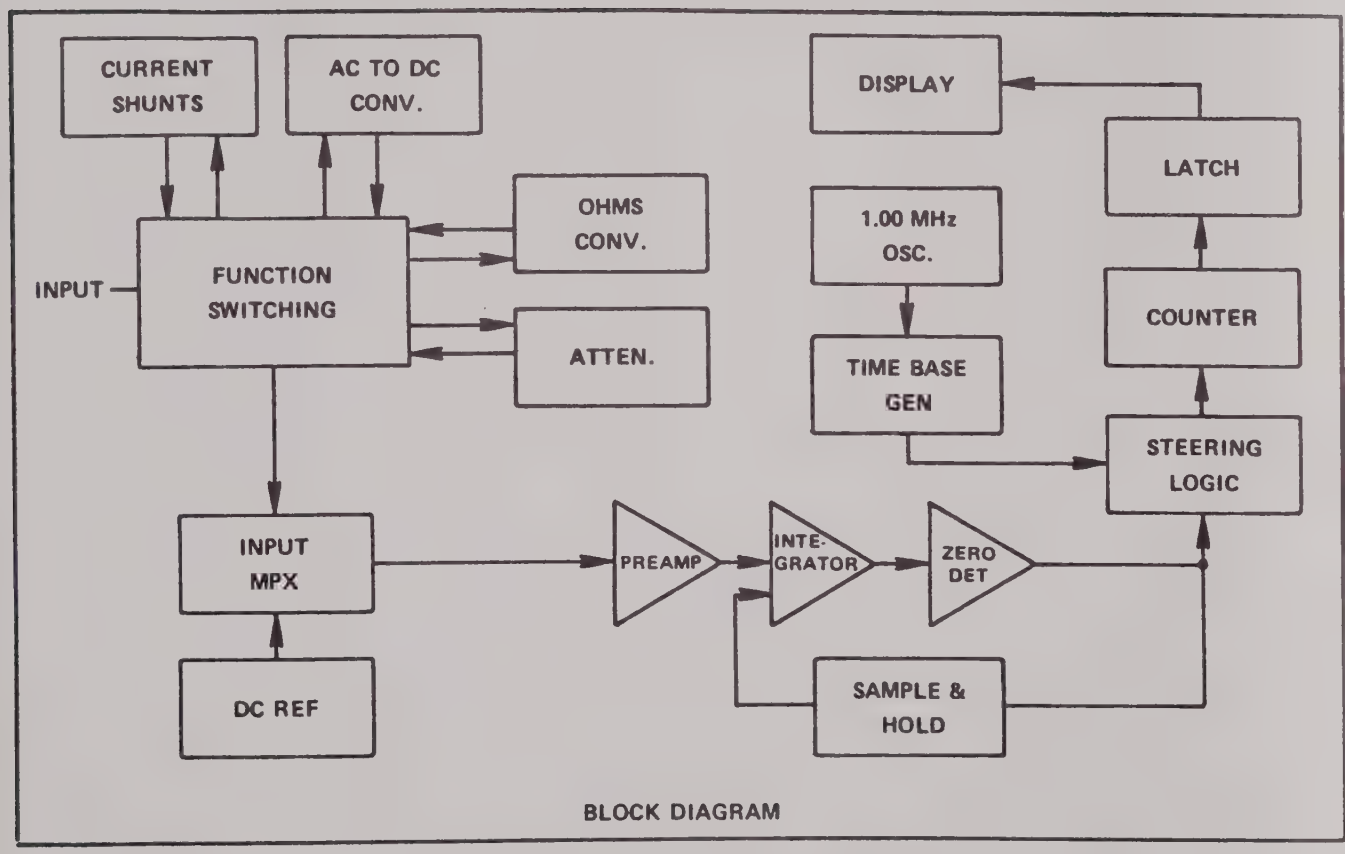

CURRENT SHUNTS
AC TO DC CONV.
DISPLAY
LATCH
OHMS CONV.
1.00 MHz OSC.
INPUT
FUNCTION SWITCHING
ATTEN.
COUNTER
TIME BASE GEN
STEERING LOGIC
INPUT MPX
PREAMP
INTE-GRATOR
ZERO DET
DC REF
SAMPLE & HOLD
BLOCK DIAGRAM

Figure 4-1

SECTION IV

THEORY OF OPERATION

4-1 INTRODUCTION

4-2 The Valhalla Scientific Model 4440 Digital Multimeter-Counter is basically a precision analog to digital converter (A/D) that measures and displays DC voltages. The measurements of DC current, AC voltage, AC current and resistance are accomplished by first converting these inputs to DC voltages and then measuring them with the precision A/D converter. Frequency measurements are made by gating the unknown input frequency into the decade counter for a fixed period of time. The instrument is completely solid state and used CMOS integrated circuits almost exclusively to minimize the power required for operation. It is basically a DC powered unit using four "D" size cells of the disposable or rechargeable type.

4-3 FUNCTIONAL DESCRIPTION

4-4 A/D CONVERTER

4-5 The Model 4440 uses a three step integration process for converting analog input voltages into digital information. The first step is 200 milliseconds long and is the RESTORE mode. In this mode, the input to the amplifier, IC12, is grounded through one section of the quad-bilateral switch, IC2. The sample and hold switch, Q15, is ON, closing the feedback loop around the integrator, IC13, and the zero detector, IC14, to drive the output of the zero detector to zero and charge capacitor C21 to the level required to hold the output at zero in the absence of an input voltage. Any offsets in the preamplifier, integrator or zero detector are automatically cancelled out.

4-6 The second step in the process integrates the unknown input voltage and begins by disabling Q15 and connecting the input of the amplifier to the input of the instrument. Depending on the selected range, the amplifier will operate at a gain of 1 or gain of 10. A gain of 10 is selected by grounding R28 through one section of the quad-bilateral switch, IC3, in the ranges of 200mv, 20V and 2000V. In the other ranges the switch is open, R28 is not grounded and the gain is 1. The output of the amplifier is applied to the input of the integrator. The integrator output will rise to a level proportional to the input. During this period, the polarity of the output of the zero detector will be applied to the D input of one half of the dual D flip-flop, IC6. The integration will last for 100 ms. At the end of that time, the input to the flip-flop will be clocked through to its Q output storing the input polarity information.

4-7 At the beginning of the third step, the input of the preamplifier is disconnected from the unknown input and connected to a reference voltage of a polarity opposite to that of the unknown input voltage. The polarity stored at the Q output of IC6, terminal 1, determines which of the two reference voltages is applied to the input of the preamplifier. Whereas the slope of the integrator output and the level at the end of integration was a function of the input voltage in the preceeding step, the slope during integration of the reference is constant. Therefore, an accurate measure of the time to integrate the reference to zero is an accurate measure of the input voltage. During this period, the crystal controlled clock is being

counted by IC7. When the zero detector output passes through zero, the counting of the clock is stopped and the count displayed on the LED readout. The zero detector also sets the monostable comprised of IC4 8-9-10 and IC4 11-12-13 which sets the unit back into the RESTORE mode for a period of 200 ms.

4-8 REFERENCE AMPLIFIERS

4-9 The two reference voltages, one positive and one negative, which will be applied to the input of the preamplifier during the third step of the measurement process must be precise and equal. These are developed in two of the amplifiers in IC15. The current for the reference zener is obtained from constant current source, Q9. The zener voltage is sensed by IC15 at terminal 3 and the feedback from the output to terminal 2 is selected to create an output of approximately -1.05 volts. This negative voltage is then applied to input terminal 6 through R66. The gain of the second amplifier of IC15 is set at -1 and the output is +1.05 volts. The feedback loop to the non-inverting input, terminal 5, of IC15 is from potentiometer R61 and permits adjustment of the balance between the two reference voltages. The two outputs are then connected to the quad-bilateral switch, IC2, which will switch the correct polarity to the voltage divider comprised of R21, R22, R23 and R24. The other quad-bilateral switch, IC3, will connect +1 volt, +0.1 volt, -1 volt or -0.1 volt to the input of the preamplifier depending on the polarity of the input signal and the gain of the amplifier as determined by the selected range.

4-10 AC TO DC CONVERTER

4-11 The Model 4440 is basically a DC voltmeter. It is necessary to rectify the AC input before applying it to the input of the A/D Converter. Rectification and amplification are accomplished in the circuits associated with Q7 and IC16. The AC input is applied to Q7, which operates as a source follower, through C9 and R38. Its output is coupled through C10 to the voltage divider R33-R34. The input to IC16 at terminal 3 is one-half of the input at Q7. The output of IC16 is coupled, through C16, to two diode rectifiers, CR7 and CR8. Through the network of R44-C17 and R45-C18, the output connects back through C15 to the inverting input of the amplifier. The amplifier will operate at a gain of 1 in the 2 volt full scale range. In the 200 millivolt range, the series combination of R36 and R37 is connected to ground, thereby changing the input level to terminal 2 of IC16 and the gain is increased to 10. The voltage at the cathode of CR8 will be the same for a 100 mv input as with a 1 volt input. The rectified AC is filtered through R46, R47 and C19. The DC component at the junction of R46 and R47 is proportional to the RMS value of the input AC voltage. This DC voltage is applied through the selector switch assembly to the input of the DC voltmeter section. The gain of the AC amplifier is 10 in ranges of 200 mv, 20 volts and 2000 volts. In ranges of 2 and 200 volts, the amplifier gain is 1.

4-12 OHMS TO DC CONVERTER

4-13 The OHMS to DC converter functions to generate a constant current through the unknown resistance connected across the input terminals. The voltage drop across the unknown is measured by the DC voltmeter and displayed as the unknown resistance.

The constant current source is comprised of two sections of IC15, IC17, Q8 and associated components. The +1.05 volt reference of IC15 terminal 7 is applied to terminal 13 through R58 and R59. The feedback to the summing junction is adjusted with R69 to produce -1V at the output terminal 14. This is applied to a floating differential amplifier input, terminal 9 of IC15. The positive feedback for this amplifier is from a voltage divider between the constant current source output, cathode of CR9, and ground. The output of the floating differential amplifier drives one input of IC17, which, in turn, drives the constant current source, Q8. The amount of current that will flow in the external resistance will be determined by the resistance between the constant current source output and the lower end of R75 which is connected to the input terminal. In the 200Ω and 2KΩ ranges, the resistance is comprised of a single 1K ohm resistor, R90. The current through the unknown resistor is 1 ma. In the 20KΩ and 200KΩ ranges, a 99K ohm resistor, R84, is switched in series with R90 for a total of 100K ohms and the current is 10 microamps. In the 2MΩ and 20MΩ ranges, R83, a 9.9M ohm resistor, is added for a total of 10M ohms and the current is then 100 nanoamps.

4-14 FREQUENCY COUNTER

4-15 The frequency counter is a crystal controlled true gated time counter. The precision time bases are derived by a 1 MHz crystal driving a series of decade counters. The counters are contained in IC11 and are programmed by the range switch to count the crystal oscillator to 100,000 for the 0.1 second gate, to 1,000,000 for the 1 second gate and to 10,000,000 for the 10 second gate. During the count time, the gate is open and the unknown frequency is counted in IC7 and displayed on the LED readout at the end of the gate time. The unknown input frequency is applied to the gate of Q13 which is protected from overvoltage by the circuit of Q14. Q13 operated as a source follower and drives NAND gate IC18 to produce a square wave at terminal 6. In the four lower ranges, the output of IC18 is applied directly to the input of IC7. In the 2 MHz range, it is first divided by 10 in IC19 and then applied to the input of IC7. In the 20 MHz range, it is first divided by 10 in IC19 and then again by 10 in IC20 for a total division of 100. The input to IC7, then, will never be greater than 200 KHz.

4-16 LED DISPLAY

4-17 At the completion of the count, in any mode of operation, the count is stored in four registers in IC7. IC7also has an internal oscillator which is set by C4 to approximately 10 KHz. There are four output terminals on IC7 (2,3,23 and 24) which are connected to decoder-driver IC10. These will be sequentially connected to the four internal registers of IC7 at a 10 KHz rate. Simultaneously, the four driver transistors, Q2 through Q5, will be turned on sequentially. When the data for the most significant digit is connected to the output of IC7, Q5 will be turned on and the decoded data will appear on DS2. When the next most significant digit data is connected to the output terminals of IC7, Q4 will turn on and the data will appear on DS3. The same process continues for DS4 and DS5 and then the process is repeated. Since the strobe rate is 10 KHz, the eye sees the display as being continuously illuminated.

SECTION V
MAINTENANCE

5-1 INTRODUCTION

5-2 This section contains the maintenance information for the Valhalla Scientific Model 4440 Digital Multimeter-Counter. Included in this section are the required test equipment list and calibration procedures.

5-3 REQUIRED TEST EQUIPMENT

5-4 EQUIPMENT	REQUIRED PERFORMANCE
DC Voltage Standard	±0.003% accuracy 0.1V to 1000V
AC Voltage Calibrator	±0.02% accuracy 0.1V to 500V RMS
DC Current Calibrator	±0.01% accuracy 0.1MA to 1000MA
AC Current Calibrator	±0.05% accuracy 0.1MA to 1000MA RMS
Precision Resistor Set	±0.005% accuracy 100 ohms to 10M ohms
Oscilloscope	50MVDC/CM Sensitivity

5-5 CALIBRATION PRODCEDURE

5-6 The following procedure should be performed on a routine basis to insure that the instrument remains within calibration. The calibration procedure should be performed after repairs to any of the accuracy determining components. Apply power and allow 5 minutes for the instrument to warm up.

5-7 DC VOLTAGE CALIBRATION

NOTE

Calibration adjustments and locations are identified in the instrument's cover for calibration convenience.

5-8 Select the DC V function and the 200mv range. Apply an input of +0.00010 volts DC and adjust the reading. Apply an input of -0.00010 volts DC and adjust R60 until both the + and - inputs produce the same display indication. After both inputs produce the same indication adjust R3 until the display indicated ±00.08 or ±00.09.

5-9 Select the DC V function and the 200 mv range. Apply an input of +100.00 mv DC. Adjust R23 until the display indicates +100.00 ±2 digits.

5-10 Select the DC V function and the 2V range. Short the input and adjust R108 until the display indicates 0.000.

5-11 Select the DC V function and the 2V range. Apply an input of +1.0000 volts DC. Adjust R21 until the display indicates +1.0000 ±2 digits.

5-12 Select the DC V function and the 2V range. Apply an input of -1.0000 volts DC. Adjust R61 until the display indicates -1.0000 ±2 digits.

5-13 RESISTANCE CALIBRATION

5-14 Select the KΩ function and the 2K ohms range. Connect a 1.0000K ohm resistor to the input terminals and adjust R69 for an indication of 1.0000 ±2 digits.

5-15 AC VOLTAGE CALIBRATION

5-16 Select the ACV function and the 2 volt range. Apply 1.0000 VRMS at 1 KHz to the input terminals and adjust R42 for an indication of 1.0000 ±5 digits.

5-17 Select the ACV function and the 200 mv range. Apply 100.00 mv RMS at 1 KHz to the input terminals. Adjust R36 for an indication of 100.00 ±5 digits.

5-18 Select the ACV function and the 20 volt range. Apply 10.0000 VRMS at 10 KHz to the input terminals and adjust C37 until the indication is 10.000 ±5 digits.

5-19 FREQUENCY COUNTER CALIBRATION

5-20 Select the KHz function and the 10KHz range. Apply a 0.1 volt RMS AC input and adjust KHz bias control, R102, for maximum sensitivity.

5-21 The remaining ranges and functions require no further calibrations. If verification of accuracy is required, apply a known input near full scale and check for specified accuracy.

5-22 TROUBLE SHOOTING

5-23 Difficulties often arise due to misinterpretation of specifications or noisy inputs. Check carefully that the instrument is truly malfunctioning before attempting to repair it.

5-24 Whenever attempting to repair a complex system, it is beneficial to isolate the malfunction to as small an area as possible before troubleshooting the malfunction. for example, if a malfunction occurred measuring a 100K ohm resistor, first check the lower resistance ranges, then check the 200 mv DC range. With this process, the malfunction may be isolated to a small area quickly.

5-25 The following table (Figure 5-1) is a functional description of the gates used in the Model 4440. For specific pin numbers, refer to the schematic diagram. All logic used in the Model 4440 is positive "1" state.

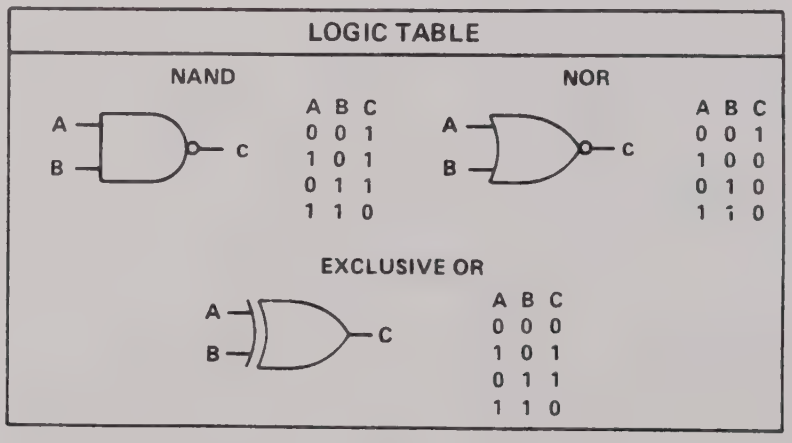


Figure 5-1

5-26 POWER SUPPLIES

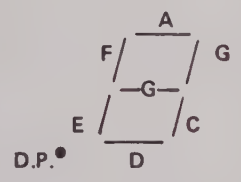
5-26 The ±5 volt supply is obtained directly from the battery pack. The voltage will vary from 4.5 volts to 6.4 volts depending on battery type and condition. The -5 volt supply is obtained from a DC to DC converter and voltage regulator system. The DC to DC converter is comprised of T1, Q11 and Q12. The secondary output of T1 is rectified and filtered and then regulated to 5 volts by the emitter follower, Q10.

5-27 The -10V supply is obtained from the junction of CR19 and CR20.

5-28 LED DISPLAY

5-28 Figure 5-2 lists the connections to the individual LED seven segment display units.

LED PIN NUMBER TABLE



SEGMENT	PIN
A	1
B	13
C	10
D	8
E	7
F	2
G	11
D.P.	6

Figure 5-2

5-29 Figure 5-3 shows the alpha characters that indicate a malfunction in the unit.

ALPHA CHARACTER TABLE

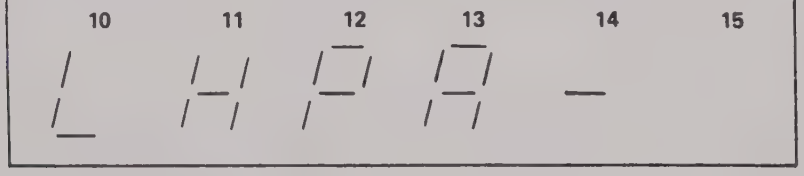


Figure 5-3

5-30 CURRENT SHUNTS

5-31 In the event of a malfunction in the DC current function, the probable failure

is the input protection fuse or the internal current shunt resistors. A simple continuity check will verify the integrity of the input fuse. The Valhalla Model 4440 may be used to trouble shoot its own current shunts. To check the current shunts, select the 2000 range and the KΩ function. Connect the V-Ω-F front panel terminal to the left side of R85 through R89 for signs of heat damage. Replace the defective resistor with a precision wire wound resistor of the same type and tolerance.

5-32 For troubleshooting the more complex feedback systems of the integrator, ohms converter and AC converter, refer to the theory of operation, SectionIV.

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	B 1-4	5-10029	Battery Alkaline "D"	Gould	E95	4					
2	Q17	3-10010	Transistor	04713	2N4402						
3	C1-2, 8, 34	2-10009	Cap. Cerm. .001UF	56289	5GAD10	4					
4	C 4	2-10002	Cap. Cerm. 500pf	56289	5GAT50	1					
5	C 5, 6	2-10010	Cap. Cerm. 39pf	56289	5GAQ39	2					
6	C7, 16-18, 20,										
	25, 33, 35,41	2-30001	Cap. Tan 10uf25V	05397	T360B106M025AS	9					
7	C9-13,28,30,										
	36, C3	2-10000	Cap. Cerm. .005uF	56289	5GAD50	9					
8	C 14	2-70002	Cap. Var. 1-3pf	Johnson	278-0103-005	1					
9	C 15	2-30006	Cap. Tan. .47uf 10V	05397	T360B474M010AS	1					
10	C19	2-30002	Cap. Tan 33uf 10V	05397	T360B336M010AS	1					
11	C21	2-50000	Cap. Poly .22uf	27556	PA2A224	1					
12	C 22, 29	2-10005	Cap. Cerm. 50pf	56289	5GAQ50	2					
13	C 23, 42	2-10004	Cap. Cerm. .02uf	56289	5GAS20	2					
14	C 24, 26, 27	2-10007	Cap. Cerm. 330f	56289	5GAT33	3					
15	C 31	2-30000	Cap. Tan 4.7uf 10V	05397	T360B475M010AS	1					
16	C32	2-30003	Cap. Tan 47uf 10V	05397	T360B476M010AS	1					
17	C 37	2-70000	Cap. VAr 1-12pf	73899	VC58G	1					
18	C 38	2-20011	Cap. Mica 1000pf	81349	CM06D102J03	1					
19	C39	2-60002	Cap. Paper .1uf	56289	225P10491	1					
20	C40	2-10003	Cap. Cerm. 20pf	56289	5GAQ20	1					
21	C 43	2-70001	Cap. Var. 2-12pf		21FG010	1					

NOTES: INDICATE COMPONENT USED IN "TRMS" OPTION
INDICATE COMPONENT USED IN "F" OPTION
△ INDICATE COMPONENT ON DISPLAY P.C.B. 4440-701

Valhalla Scientific Inc.	PARTS LIST	UNIT AASY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N				REMARKS
22	C44	2-40004	Cap. Elec. 2200uf	30039	16T2200	1					
23	CR1,2,7-9, 12-	16,19,20,	21,22,23,29,30								
		3-20000	DIODE	07263	1N4148	17					
24	CR △6, 18	3-20002	DIODE RECT.	07263	1N4001	5					
25	CR17	3-20001	DIODE ZENNER	07263	1N821	1					
26	DS1 ⟨	5-01020	LED 1 Display	28480	5082-7656C	1					
27	DS 2-5 △	5-01010	LED 0-9 Display	28480	5082-7650C	4					
28	F 1 △2	5-04001	Fuse, 2A	75915	3GA2A	2					
29	IC 1	3-30022	IC Level Shifter	86684	CD4054AE	1					
30	IC 2, 3	3-30023	IC Quad Swithch	86684	CD4066BF	2					
31	IC4	3-30024	IC Quad NOR	86684	CD4001AE	1					
32	IC 5	3-30025	IC Quad EX. OR	86684	CD4030AE	1					
33	IC 6,8	3-30026	IC Dual D Flip Flop	86684	CD4013AE	2					
34	IC 7	3-30029	IC LSI	Hughes	HCTR4010	1					
35	IC 9	3-30027	IC Quad NAND	86684	CD4011AE	1					
36	IC 10	3-30106	IC Decoder Driver	01295	74LS47	1					
37	IC11	3-30012	IC LSI Timer	Mosteck	Mk 5009P	1					
38	IC 12,21,17	3-30074	IC-Op Amp	27014	LF356H	3					
39	IC 13	3-30017	IC Op-Amp	26014	LM308N	1					
40	IC 14, 16	3-30013	IC Op-Amp	27014	LM301H	2					
41	IC15	3-30031	IC Quad Op-Amp	27014	LM324N	1					
42	IC 18	3-30002	IC Quad NAND	27014	SN7400N	1					
43	IC 19	3-30032	IC Decade Counter	01295	SN4LS196	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
44	IC 20	3-30033	IC Decade Counter	86684	CD4017AE	1					
45	IC 22	3-30035	IC Voltage Reg.	27014	LM320-5.0T	1					
46	J1△	5-10030	Banana Jack Red	05276	1581-Red	1					
47	J2△	5-10032	Banana Jack BLUE	05276	1581-BLUE	1					
48	J3△	5-10031	Banana Jack Wht.	05276	1581-Wht	1					
49	J4	5-10033	Connector Pwr	82389	712A	1					
50	Q1-6,11,12	3-10003	Transistor NPN	04713	2N5172	8					
51	Q8	3-10015	Transistor NPN	04713	MJE3439	1					
52	Q9, 13	3-10000	Transistor FET	15818	U1899E	2					
53	Q14,15	3-10004	Transistor FET	15818	P1087E	2					
54	R120	1-01004	Res Fxd 4.7K 1/4W	81349	RC07GF4R7J	1					
55	R1,2,4,6,7,48	1-01073	Res Fxd 47K 1/4W 5%	81349	RC07GF473J	6					
56	R3,60,61,102,	1-50005	Res Var 50K 20%	71450	X201R503	5					
	108										
57	R5,25-27,38,106 75	1-01081	Res Fxd 100K 1/4W 5%	81349	RC07GF104J	7					
58	R8	1-01120	Res Fxd 12M 1/4W5%	81349	RC07GF126J	1					
59	R10, 101	1-01043	Res Fxd 1.5K 1/4W 5%	81349	RC07GF152J	2					
60	R18	1-01067	Res Fxd 24K 1/4W 5%	81349	RC07GF243J	1					
61	R19,49	1-01021	Res Fxd 100 1/4W 5%	81349	RC07GF101J	2					
62	R20,58		Factory Select			2					
63	R21	1-50002	Res Var 1K20%	71450	X201R102	1					
64	R22	1-10038	Res Fxd 90.9K .1%	81349	RN60C9092B	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
65	R23,36,69	1-50000	Res Var 100 20%	71450	X201R101	3					
66	R24,44,45,59										
	62,66,68,70,71	1-10037	Res Fxd 10K .1%	81349	RN60C1002B	9					
67	R28,31,105,110	1-01061	Res Fxd 10K 1/4W 5%	81349	RC07GF103J	4					
68	R29	1-10039	Res Fxd 274K 1%	81349	RN50C2743F	1					
69	R30	1-01080	Res Fxd 91K 1/4W 5%	81349	RC07GF913J	1					
70	R33,34,46,73										
	74, 76,77	1-10049	Res Fxd 100K .1%	81349	RN60C1003B	7					
71	R37	1-10041	Res Fxd 432	81349	RN60C4320F	1					
72	R39,109,54	1-01128	Res Fxd 1000M	81349	RC07GF108J	3					
73	R40	1-01109	Res FXD 3.3M 1/4W 5%	81349	RC07GF335J	1					
74	R41	1-10040	Res Fxd 4.42K	81349	RN60C4421F	1					
75	R42	1-50007	Res Var 250 20%	71450	X201R251	1					
76	R43,103	1-01082	Res Fxd 120K 1/4W 5%	81349	RC07GF124J	2					
77	R47	1-10028	Res Fxd 24.9K 1%	81349	RN60C2492F	1					
78	R50,55	1-01045	Res Fxd 2K 1/4W 5%	81349	RC07GF202J	2					
79	R51	1-01041	Res Fxd 1K 1/4W 5%	81349	RC07GF103J	1					
80	R52	1-01065	Res Fxd 20K 1/4W 5%	81349	RC07GF203J	1					
81	R53	1-01051	Res Fxd 3.9K	81349	RC07GF392J	1					
82	*	1-10090	Matched Atten. Set								
			9.9M, 1K, 99K								
83	R56,80,113,121	1-01007	Res Fxd 10 1/4W 5%	81349	RC07GF100J	4					
84	R57	1-01097	Res Fxd 750K 1/4W 5%	81349	RC07GF754J	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
85	R63	1-01102	Res Fxd 1.5M 1/4W 5%	81329	RC07GF155J	1					
86	R64,72, 111	1-01053	Res Fxd 4.7K 1/4W 5%	81349	RC07GF472J	3					
87	R65, 100	1-01028	Res Fxd 270 1/4W 5%	81349	RC07GF271J	2					
88	R67,78	1-10036	Res Fxd 1.62K .1%	81349	RN60C1621B	2					
89	R81,82	1-01048	Res Fxd 2.7K 1/4W 5%	81349	RC07GF272J	2					
90	*R83	1-10090	Res Fxd 9.9M	00002		1					
91	*R84	1-10090	Res Fxd 99K	00002		1					
92	R85	1-20004	Res Fxd 900 .05%	00002	J110-900	1					
93	R86	1-20003	Res Fxd 90 .5%	00002	J110-90						
94	R87	1-20002	Res Fxd 9 .5%	00002	J110-9	1					
95	R88	1-20028	Res Fxd .9 .1	00002	J110-.9						
96	R89	1-20027	Res Fxd .1 .1%	00002	J140-.1	1					
97	*R90	1-10090	Res Fxd 1K	00002		1					
98	R91,92 △	1-01093	Res Fxd 470K 1/4W 5%	81349	RC07GF474J	2					
99	R93-96,11-17△	1-01031	Res Fxd 390 1/4W 5%	81349	RC07GF391J	9					
100	R97	1-01100	Res. Fxd 1M 1/4W 5%	81349	RC07GF105J	1					
101	R98,9	1-01119	Res Fxd 10M 1/4W 5%	81349	RC07GF106J	2					
102	R99, 112	1-01036	Res Fxd 620 1/4W 5%	81349	RC07GF621J	2					
103	R104	1-01075	Res Fxd 56K 1/4W 5%	81349	RC07GF563J	1					
104	R107	1-01033	Res Fxd 470 1/4W 5%	81349	RC07GF471J	1					
105		5-10278	Panel Nut	CBK	7099	1					
106	S1,2	5-03005	Push Button Switch	71590	5-03005	2					
107	S3	5-03015	Toggle Switch	C&K	1201	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

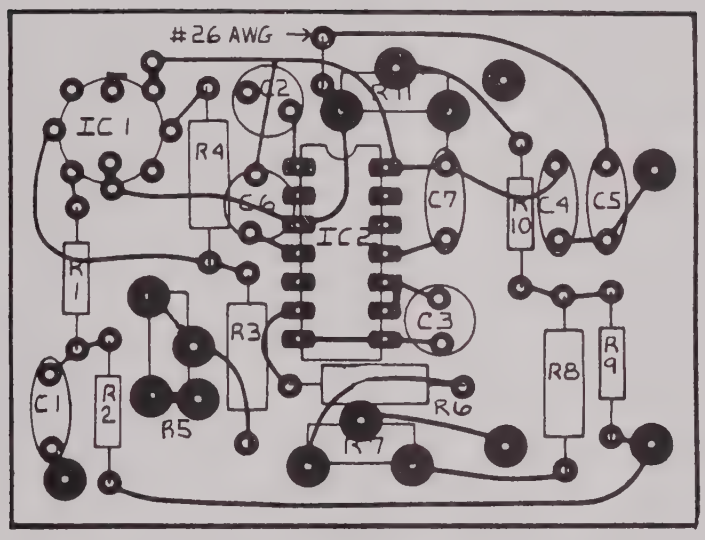
#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
108		5-10277	Silver Button	71590	B-426	12					
109	T1	4-20006	Transformer	53504	4440-010	1					
110	Y1	5-02000	1MHz Crystal	81349	HC6-1MHz	1					
111		5-10199	Fiber Washer	Smith	2161	8					
112			#4 Self Tapping Screw	1/2"lg.		4					
113			#4 Washer, Split lock			4					
114		5-10198	1/8" Spacer	Smith	8880	4					
115	△	5-10094	Fuse Holder	75915	155120	1					
116		4-30009	P.C. Board	53504	4440-700H	1					
117	△	4-30010	P.C. Board	53504	4440-701F	1					
118		5-10042	24 Pin IC Socket	01295	C8524-01	1					
119		5-10008	16 Pin IC Socket	01295	C8516-01	1					
120		5-10041	14 Pin IC Socket	01295	C8514-01	3					
121		5-10049	Battery Box	Wkman	L103	1					
122											
123		4-10234	Front Panel	53504	4440-213	1					
124		4-10130	Chassis	LaFrance	CH-250 Beige	1					
125		4-10235	Rear Panel	53504	4440 -214	1					
126		5-10018	Fuse Holder		342004A	1					
127		5-10239	Velcro Hook United Textile		VN06330HK	8	Inches				
128		5-10240	Velcro Loop United Textile		VN06330LP	8	Inches				
129		4-10130	Chassis (Includes)	LaFrance	CH250 Beige	1					
130			Handle (60128)			1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	UNIT ASSY "DC"	MODEL 4440	DWG NO 4440-400	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
131			Spring (60157)			2					
132			Button (60156)			2					
133			#4 Screw (60164)			2					
134			Cap (60170)			2					
135			Feet (60129)			4					
136			6-32 x 1/2 Screw, Phil Pan Cad			4					
137			Top Cover (60119-1)			1					
138			Spacers (60130-2)			8					
139			Side Expanders (60120)			1					
140			Bottom Cover (60119-2)			1					
			WIRE:								
			ORN 22AWG		17 in.						
			BLUE 22AWG		20 in.						
			BLACK 22AWG		28 in.						
			RED 22AWG		11 in.						
			WHITE 22AWG		5 in.						
			BUSS 22AWG		1 in.						
			BUSS 14AWG		5 in.						

NOTES: SEE ASSY DWG FOR SHEETS AND 8 and 9



TRMS AC CONVERTER

CALIBRATION PROCEDURE

Select the ACV function and the 2 volt range. Apply 0.1000 VRMS at 1 KHz to the input terminals and adjust R11 for an indication of 0.1000 ±5 digits.

Apply 1.0000 VRMS at KHz to the input terminals and adjust R7 for an indication of 1.0000 ±5 digits.

Select the ACV function and the 200 MV range. Apply 100.00 MVRMS at 1 KHz to the input terminals and adjust R5 for an indication of 100.00 ±5 digits.

Select the ACV function and the 20 volt range. Apply 10.000 VRMS at 10 KHz to the input terminals and adjust C37 for an indication of 10.000 ±5 digits. (C37 is located behind the front panel input terminals).

Valhalla Scientific Inc.	PARTS LIST	OPTION 20Hz TRMS TO DC CONVERTER	MODEL 4440	DWG NO 4440-604	REV A

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N	REMARKS
1	C1	2-10000	CAP.CERM .005µf	56289	5GAD50	1				
2	C2,3	2-30007	CAP. TAN 2.2µf	05397	T390A225M01AS	2				
3	C4,5	2-60002	CAP. PAPER .1µf	56289	225P10491	2				
4	C6	2-30008	CAP. TAN 6.8µf	05397	T390B685M01AS	1				
5	C7	2-10002	CAP. CERM 500pf	56289	5GAT50	1				
6										
7	IC1	3-30074	IC FET OP-AMP	27014	LF356H	1				
8	IC2	3-30045	IC RMS TO DC CONV.	ANALOG DEVICES	AD536JD	1				
9										
10	R1	1-01081	RES FXD 100K 1/4W 5%	81349	RC07GF104J	1				
11	R2	1-01128	RES FXD 1000m1/4W 5%	82349	RC07GF108J	1				
12	R3	1-10053	RES FXD 2.43K 1/4W 1%	81349	RN60C2431F	1				
13	R4	1-10054	RES FXD 22.1K 1/4W 1%	81349	RN60C2212F	1				
14	R5	1-50000	RES VAR 100Ω 20%	71450	X201R101	1				
15	R6	1-10055	RES FXD 113K 1/4W 1%	81349	RN60C1133F	1				
16	R7	1-50004	RES VAR 500Ω 20%	71450	X201R501	1				
17	R8	1-10056	RES FEX 12.1K 1/4W 1%	81349	RN60C1212F	1				
18	R9	1-01020	RES FEX 100Ω 1/4W 5%	81349	RC07GF101F	1				
19	R10	1-01100	RES FEX 1M 1/4W 5%	81349	RC07GF105F	1				
20	R11	1-50005	RES VAR 50K 20%	71450	X201R503	1				
21										
22										

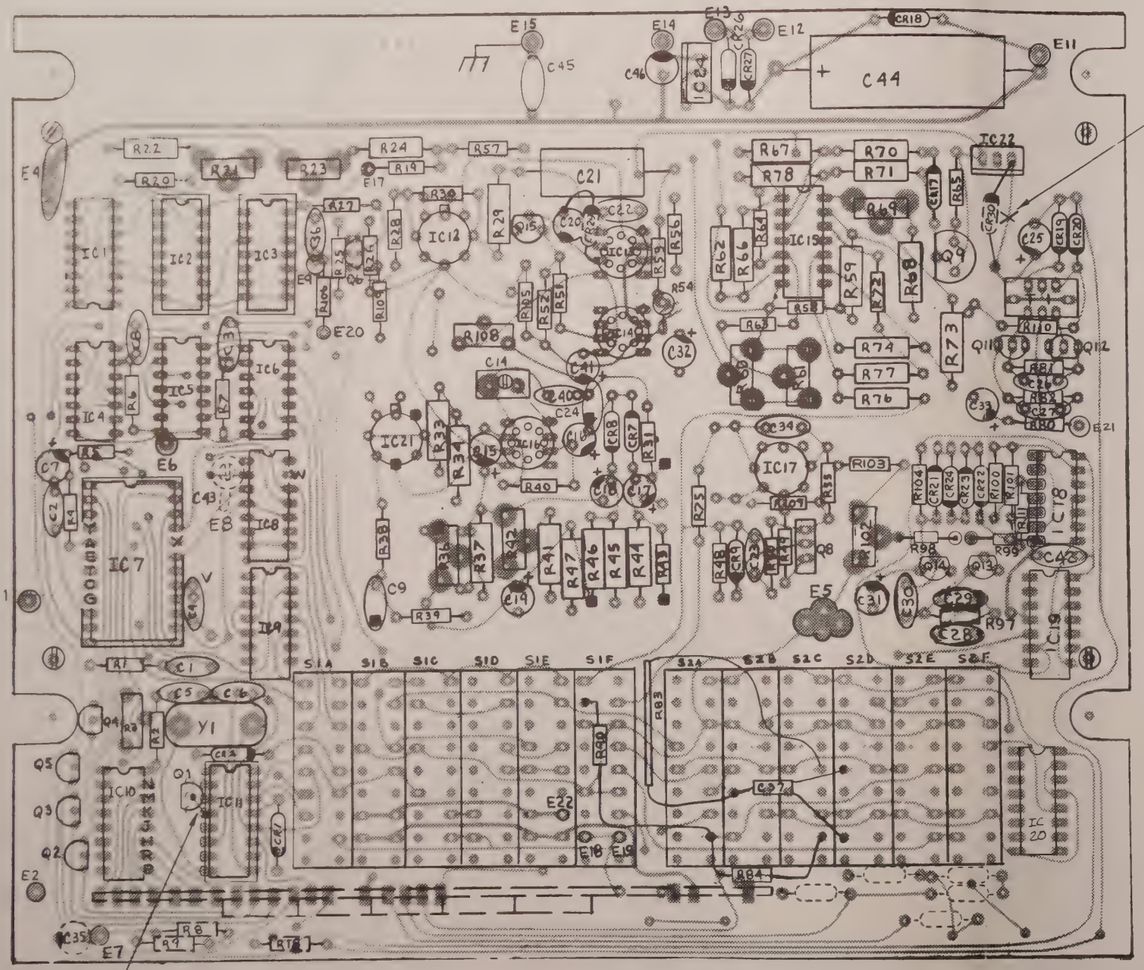
NOTES: FOR SCHEMATIC SEE DWG. NO 4440-071

Valhalla Scientific Inc.	PARTS LIST	OPTION 20Hz TRMS TO DC CONVERTER	MODEL 4440	DWG NO 4440-504	REV A

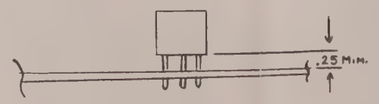
#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N	REMARKS
23		4-30021	P.C. BOARD	53504	4440-704	1				
24		5-10198	1/8 STANDOFF	83330	8880	8				

NOTES:

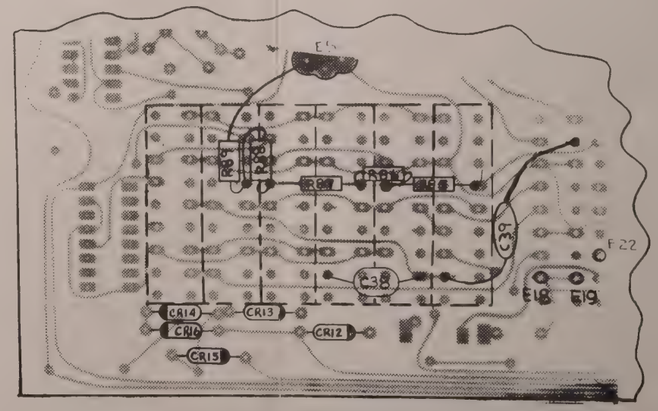
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
H	ADDED TABLE FOR BCD Rev 6/82		
K	ADDED TRANSISTORS Q112, AND ECO BALLOUT	11-3-83	



SHOWN IS P.C.B. ASSEMBLY 4440-600 VIEWED IS TOP SIDE
CLAD SHOWN IS BOTTOM SIDE



ALL TRANSISTOR AND TO-18
Q1-Q15, IC12, IC21, IC13, IC14, IC17, IC16,



SHOWN IS PARTIAL P.C.B. ASSY. OF COMPONENT MOUNTED ON BOTTOM OF SWITCHES. VIEWED FROM BOTTOM SIDE.

4. FOR PARTS LIST SEE 4440-400 SHT 1-5.
3. FOR ASSEMBLY DRAWING SEE 4440-400 SHT 8.
2. FOR WIRE TAB TABLE SEE 4440-051
1. FOR SCHEMATIC SEE DRAWING 4440-070

NOTES:

MATERIAL	DRAWN MC 9/82	Valhalla Scientific Inc.	
	CHECKED RM 9/82	SAN DIEGO, CALIFORNIA	
	APPR.		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND SHOULD NOT BE DISCLOSED EXPRESSLY GRANTED IN WRITING. IT IS LOANED SUBJECT TO VALHALLA'S RIGHTS GOVERNING ITS PATENT SALE. PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO	ASSEMBLY P.C.B. DIGITAL MULTIMETER 4440	
	SCALE NONE	CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 4440-600 / REV K	
	SHEET 1 OF 1		

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	F	ECO 02. Rm 10/81		

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

NEXT ASSY | USED ON

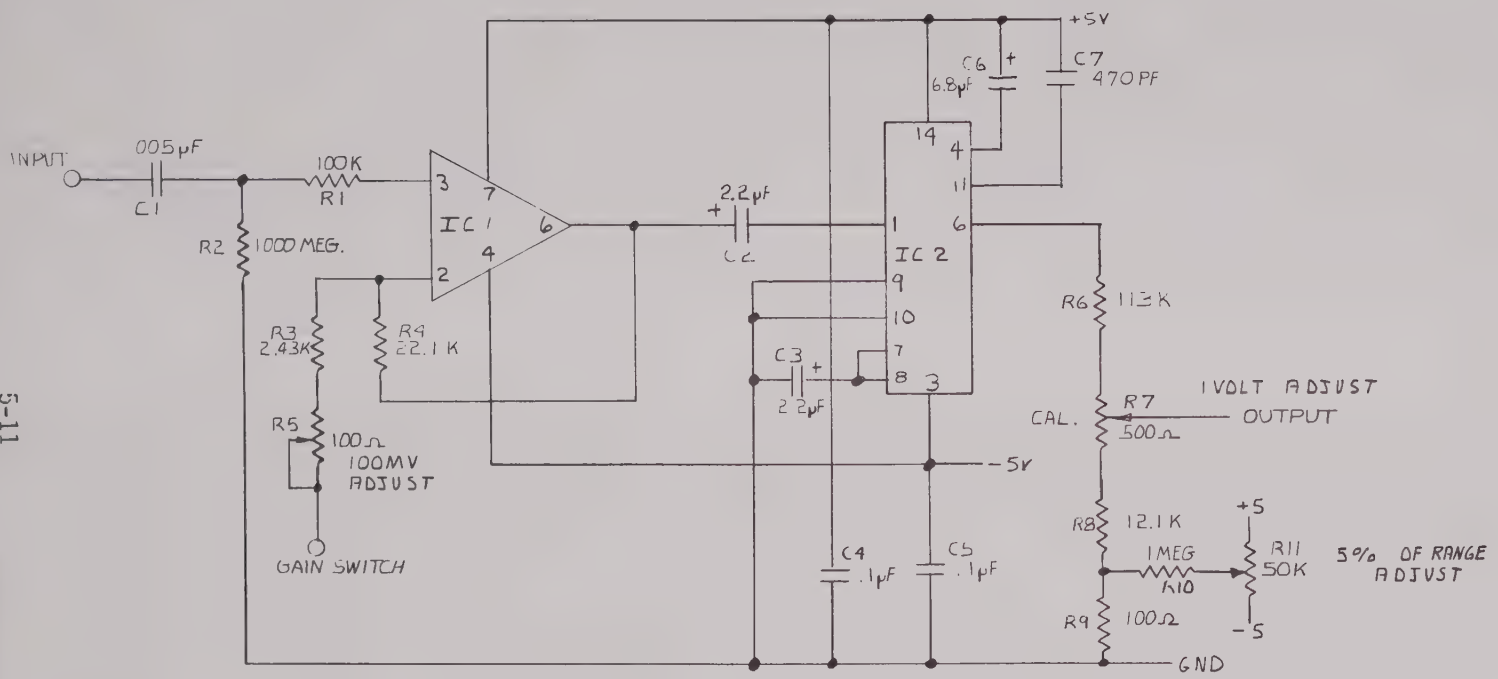
APPLICATION

Valhalla Scientific Inc.

SIZE	CODE IDENT NO.	DRAWING NO.
D		4440-070F

SCALE | SHEET OF

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED MODIFICATION NOTE C.R.E.	1-27-82	



5-11

MODIFICATION FROM 4440 TO 4440 AF (3Hz)

CHANGE	FROM	TO
C2	2.2μ	47μ (2-30003)
C3	2.2μ	47μ (2-30003)
C6	6.8μ	33μ (2-30002)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
± .XX ± ±
.XXX ±

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN	
CHECKED	

PC 4440-704

VALHALLA SCIENTIFIC

4440 TRMS AC CONV.

SIZE	CODE IDENT NO.	DRAWING NO.	REV.
B	53504	4440-071	A

SCALE | SHEET 1 OF 1

Federal Supply Codes for Manufacturers

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

00853
Sangamo Electric Company
Pickens, South Carolina

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01255
Litton Industries, Inc.
Beverly Hills, California

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Dallas, Texas

01686
RCL Electronics Inc.
Manchester, New Hampshire

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Westwood, Maine

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Syracuse, New York

03797
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03911
Clairex Corp.
Mt. Vernon, New York

04009
Arrow Hart Inc.
Hartford, Connecticut

04217
Essex International Inc.
Anaheim, California

04222
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04713
Motorola Inc.
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05276
Pomona Electronics Co., Inc.
Pomona, California

05277
Westinghouse Electric Corp.
Youngwood, Pennsylvania

05397
Kemet, Union Carbide Corp.
New York, New York

05574
Viking Industries
Chatsworth, California

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Columbia, South Carolina

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06743
Clevite Corp.
Cleveland, Ohio

07088
Kelvin Electric Company
Van Nuys, California

07256
Silicon Transistor Corp.
Chelmsford, Massachusetts

07263
Fairchild Semiconductor
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Rochester, New York

07716
I R C Incorporated
Burlington, Iowa

07910
Teledyne Semiconductor
Hawthorne, California

08065
Accurate Rubber and Plastics Co.
San Diego, California

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Cleveland, Ohio

09026
Babcock Electronics Corp.
Costa Mesa, California

09214
G. E. Co. Semi-Conductor
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

11236
CTS of Berne
Berne, Indiana

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Hicksville, New York

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12405
Hysol Corporation
El Monte, California

12406
Elpac, Incorporated
Fullerton, California

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13454
Texas Crystals
River Grove, Illinois

13511
Amphenol Cadre Div.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Concord, New Hampshire

14099
Semtech Corp.
Newbury Park, California

14655
Cornell-Dublier Electronics
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14936
General Instrument Corp.
Hicksville, New York

15801
Fenwal Electronics Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors
Mountain View, California

15849
Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Cambridge, Maryland

16758
Delco Electronics
Kokomo, Indiana

17856
Siliconix, Inc.
Santa Clara, California

18324
Signetics Corp.
Sunnyvale, California

Federal Supply Codes for Manufacturers (cont.)

18612
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18722
R C A
Mountaintop, Pennsylvania

18927
GTE Sylvania Inc.
Titusville, Pennsylvania

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23936
Pamotor Div.
Burlingham, California

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Slatersville, Rhode Island

25684
Victoreen Instrument Co., Inc.
Oak Lawn, Illinois

27014
National Semiconductor Corp.
Santa Clara, California

27556
IMB Electronic Products
Santa Fe Springs, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
St. Paul, Minnesota

28480
Hewlett Packard Co.
Palo Alto, California

29083
Monsanto Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

30983
Electra/Midland
San Diego, California

32539
Mura Corp.
Great Neck, New York

32897
Erie Technological Products, Inc.
Carlisle, Pennsylvania

32997
Bourns Inc.
Riverside, California

33173
General Electric Co.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

43543
Nytronics Inc.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

53504
Valhalla Scientific, Inc.
San Diego, California

54294
Cutler-Hammer Inc.
Selma, North Carolina

55026
Simpson Electric Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

65092
Weston Instruments Inc.
Newark, New Jersey

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71279
Cambridge Thermionic Corp.
Cambridge, Massachusetts

71400
Bussmann Mfg.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Brooklyn, New York

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73445
Amperex Electronic Corp.
Hicksville, New York

73734
Federal Screw Products, Inc.
Chicago, Illinois

73899
JFD Electronics Co.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74276
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76055
Mallory Controls
Frankfort, Indiana

76493
J.W. Miller Company
Los Angeles, California

76854
Oak Industries Inc.
Crystal Lake, Illinois

77342
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp.
Cleveland, Ohio

80031
Electro-Midland Corp.
Mepco Div.
Norristown, New Jersey

56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

81073
Grayhill, Inc.
La Grange, Illinois

Federal Supply Codes for Manufacturers (cont.)

81095
Triad Transformer Corp.
Venice, California

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
International Rectifier Corp.
Los Angeles, California

81741
Chicago Lock Co.
Chicago, Illinois

82389
Switchcraft Inc.
Chicago, Illinois

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83298
Bendix Corp.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83594
Burroughs Corp.
Plainfield, New Jersey

83740
Union Carbide Corp.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Peabody, Massachusetts

86684
Radio Corp. of America
Harrison, New Jersey

88219
Gould Inc.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Fuquay-Varian, North Carolina

89730
G.E. Co.
Newark, New Jersey

90201
Mallory Capacitor Co.
Indianapolis, Indiana

56365
Square D Co.
Chicago, Illinois

90303
Mallory Battery Co.
Tarrytown, New York

91094
Essex International Inc.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Woburn, Massachusetts

94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95712
Bendix Corp.
Franklin, Indiana

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

98278
Malco A. Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98978
IERC
Burbank, California

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Landsdowne, Pennsylvania

99942
Centrelab Semiconductor
El Monte, California

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